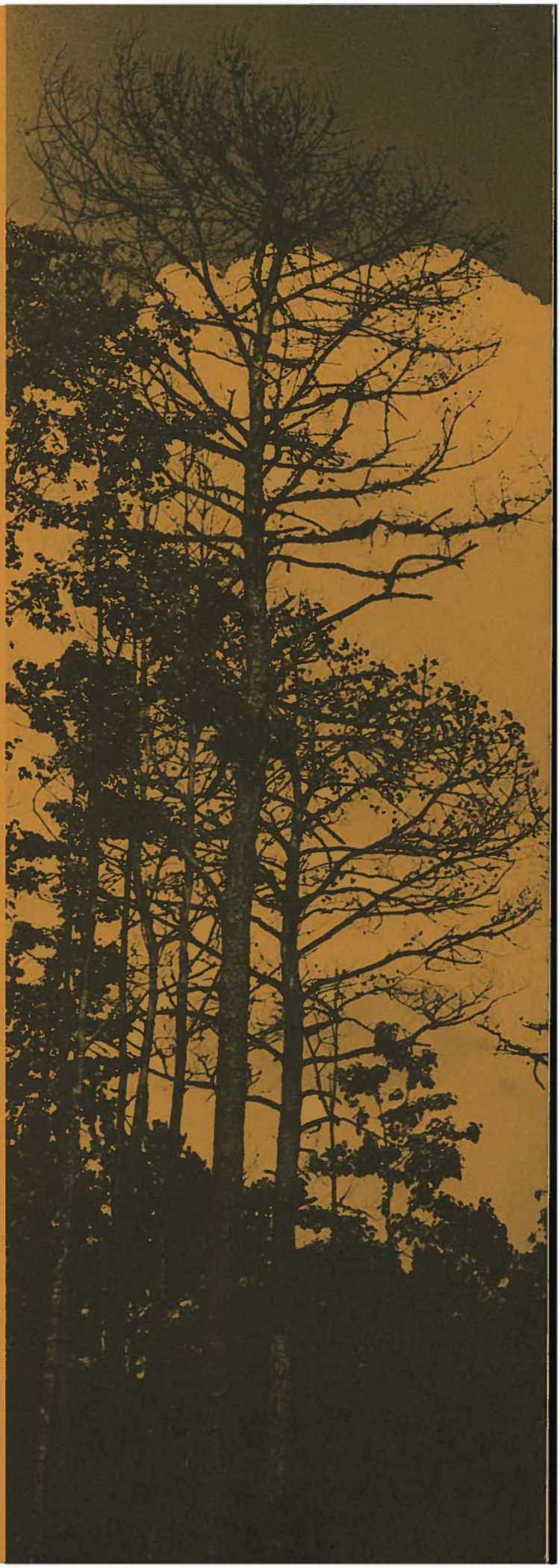
1972 1973

Texas Forest Pest Activity and Forest Pest Control Section Annual Report



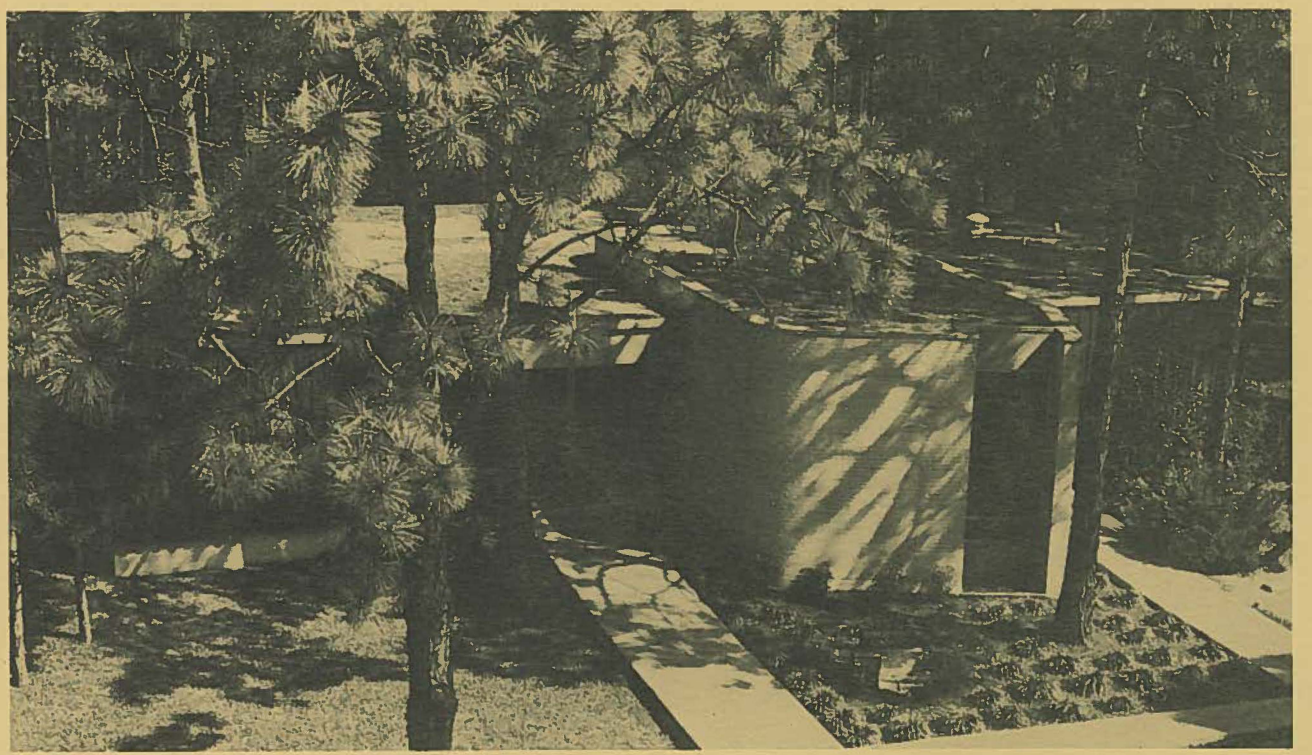
TEXAS FOREST SERVICE
Circular 219

TEXAS
FOREST PEST ACTIVITY
1972 1973
AND
FOREST PEST CONTROL SECTION
ANNUAL REPORT

PRIVATE FOREST INDUSTRY
and
NATIONAL FORESTS IN TEXAS
COOPERATING

TEXAS FOREST SERVICE
A PART OF
THE TEXAS A&M UNIVERSITY SYSTEM

May
1974



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INTRODUCTION

The Forest Pest Activity Report has been published since 1967 by the Pest Control Section to summarize losses caused by forest pests and to serve as a historical record of insect and disease activity in the forests of Texas. As a reflection of the ever-increasing interest in forest entomology and pathology, the report this year has been expanded to provide both a summary of pest activity and control programs for 1972 and 1973 and a synopsis of recent developments, personnel changes, research projects and activities concerning the Texas Forest Service Service Pest Control Section.

TEXAS FOREST PEST STATUS, 1972 - 1973

SOUTHERN PINE BEETLE

During 1972 and 1973, as in past years, bark beetles were the pests most destructive to Texas' forests. Of the five species of pine bark beetles found throughout the South, the southern pine beetle, *Dendroctonus frontalis,* continued to pose the greatest threat to pine forest resources.

Southwide SPB Infestation Status

The current southern pine beetle outbreak is not confined to Texas but has reached epidemic proportions throughout the South. According to a recent U.S. Forest Service report*, the beetle is threatening forests on 78 million acres in ten states, from Texas to Virginia. The net acreage of susceptible pine type that is infested is estimated to be 53,160,000 acres, or 62 percent of the total susceptible commercial pine type in the entire South and Southeast. Beetle infestations have increased in intensity or expanded in range significantly since 1971 in South Carolina, Georgia, Alabama, Mississippi and Texas, and no general collapse of the outbreak is foreseen in the immediate future.

During the period July 1971 through August 1973, a total of 256,478,000 board feet of sawtimber and 45,600,000 cubic feet of pulpwood killed by the beetle was salvaged throughout the South. Not included in these figures is the frequent pine tree mortality resulting from bark beetle activity in suburban communities. Losses of yard and shade trees in residential areas cannot be realistically expressed solely in terms of volume, since the aesthetic value of dead trees far exceeds their monetary value.

State and federal funds expended for southern pine beetle control southwide in fiscal years 1972 and 1973 totaled $225,689 and $1,645,506, respectively. Funds requested from state and federal sources for 1974 amount to $2,343,000. These figures reflect the increasing severity of the beetle problem.

*Southern Pine Beetle Outbreak Status—1973. U.S. Forest Service, Southeastern Area State & Private Forestry, Atlanta, Georgia (Unpublished manuscript).

SPB in East Texas 1972 - 1973

The total number of multiple tree infestations (spots) detected by aerial surveillance provides one measure of the magnitude and annual variation of beetle activity during the past five years in East Texas (Table 1). Only spots consisting of five or more active brood trees were recorded.

TABLE 1. SPB Spots Detected by Aerial Observation.

Year	Total spots detected
1969	1636
1970	867
1971	1376
1972	5190
1973	3853

As indicated by these data, beetle activity reached a peak level during 1972 and declined somewhat in 1973. Of the 3,853 new spots detected statewide during 1973, 3,386 (88 percent) were verified subsquently by ground check crews and at least 1,276 (33 percent) received control action. By the end of the year, 1,887 of the untreated spots had gone inactive.

Figure 1 illustrates the number of new spots detected per month for 1972 and 1973 compared to the average annual pattern of spot detection based on the five-year interval from 1967 to 1971. In previous years, May and June have been the months of peak spot detection. The unusually high number of beetle spots detected during July 1973 may well include spots which should be attributed to earlier months because certain fringe areas

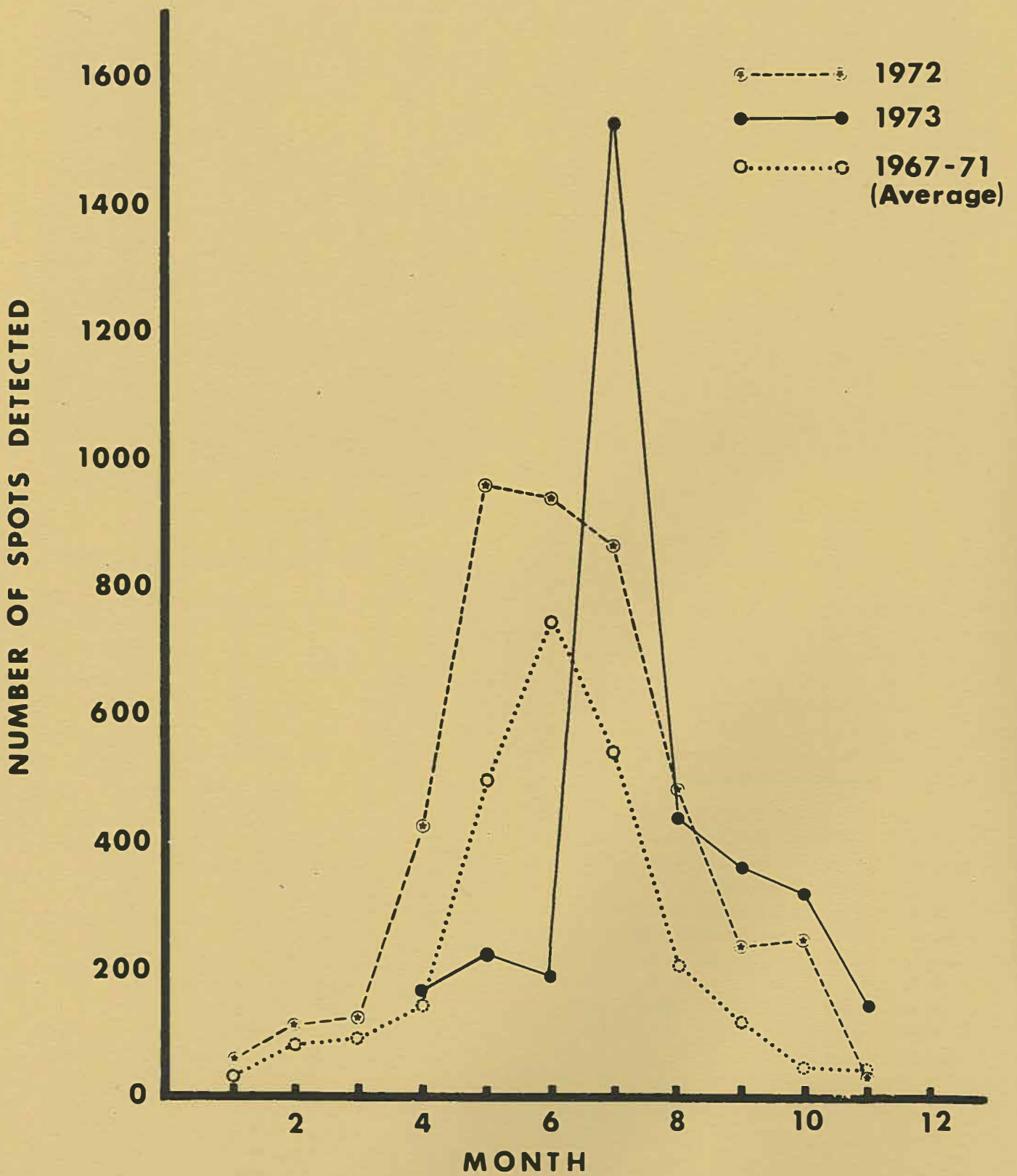


Figure 1. Pattern of Statewide SPB Spot Detection by Month for 1972 and 1973 Compared to Five-Year Average (1967-1971).

were not flown regularly until mid-summer. Further, because of abnormally cool, wet weather last spring, foliage of beetle-killed trees was slow to fade.

A summary of 1973 beetle infestation levels by county is provided in Appendix 2. The ten counties, listed in decreasing order of magnitude, which suffered the greatest number of infestations were Montgomery, Trinity, Nacogdoches, Angelina, San Jacinto, Walker, Polk, Tyler, Liberty and Hardin. Of particular interest was the substantial number of new infestations reported in counties having little or no previous history of beetle outbreaks—i.e., Nacogdoches, Angelina, Cherokee, Houston, San Augustine, Shelby and Walker. Why the infestation area in 1973 abruptly shifted to previously uninfested counties to the north and west of the 1968-72 infestation zone (Figure 2) remains unclear. This shift is also reflected by the district spot summaries (Figure 3). Infestation levels declined markedly in Texas Forest Service District 5, Kirbyville, and increased in TFS District 3, Lufkin. Federal lands suffered heavy infestations for the first time, with the Raven, Trinity and Neches Ranger Districts of the Sam Houston and Davy Crockett National Forests experiencing severe losses.

Specific data on Texas Forest Service man-hours involved and acreages covered in SPB detection and ground-check activities during the period 1 July 72 to 31 December 73, was derived from state and federal activity (MARS) summaries and is provided in Appendix 3.

SPB Control Program

In 1973, the most common and recommended control was salvage removal (Table 2), which accounted for 57 percent of the total control effort. It is interesting to note that only 1 percent of the spots were controlled solely with chemical insecticides benzene hexachloride (BHC), the primary method of beetle control prior to 1969.

Due to excessive rainfall, which made many infestations inaccessible to salvage logging equipment, a substantial number of spots were controlled by tactics known as "cut and leave" or "cut and top." These procedures consist of felling all active brood trees toward the center of the spot and cutting a 40-50 foot buffer strip of green uninfested trees around the active periphery of the spot. In winter months (November-April), crowns of felled trees may be severed (cut and top). Theoretically this control action discourages continued expansion of the spot by disrupting the necessary flow of beetle-produced attractants. Accordingly, emerging beetles tend to disperse rather than attack adjacent green trees. Further, the felled trees are more apt to provide adverse conditions for brood development and survival. Research is now in progress to critically evaluate the effectiveness of this control tactic.

A summary of the volumes of SPB-killed timber salvaged during 1973 on federal and industry lands is presented in Table 3. These figures were derived from reports of 38 major cooperating landowners and the U.S. Forest Service. A total of 19,988,200 bd. ft. of sawtimber and 17,656 cords of pulpwood was salvaged from approximately 4,000 acres. It is also estimated that of the timber killed by SPB throughout the state in 1973 approximately 15,500,000 bd. ft. of sawtimber and 23,000 cords of pulpwood were not salvaged, but were left in the woods.

TABLE 2. Summary of Total State Effort 1973 SPB Control.

Type of control	3	4	5	6	State totals
Salvage	231	202	28	269	730
Frontalure	0	3	4	0	7
Cut & leave	128	94	17	94	333
Cut & top	12	46	17	34	109
Insecticide	4	4	5	2	15
Combination	26	21	10	25	82
Total					1276
Inactive	813	459	88	529	1889
Total 1973 SPB Spots Controlled or Inactive					3165

TABLE 3. Estimated Volume of Beetle-Killed Sawtimber and Pulpwood Salvaged During 1973 on Federal and Private Lands.

National Forest	Sawtimber (BF)**	Pulpwood (cords)	Total (feet)***
Sabine	2,144,900	285	379,000
Angelina	204,900	49	37,900
Sam Houston	5,362,800	5,732	1,326,000
Davy Crockett	4,911,600	25	820,500
Total federal	12,624,200	6,091	2,563,300
Total private*	7,364,000	11,565	2,099,334
Grand total salvage (Federal & Private)	19,988,200	17,656	4,662,634

*Estimates based on sample of 195 spots representing 42% of total spots salvaged on private holdings.
**All figures converted to International ¼" Log Ruled.
***Conversion factors: 167 cubic feet/M bd. ft. and 75.4 cubic feet/cord.

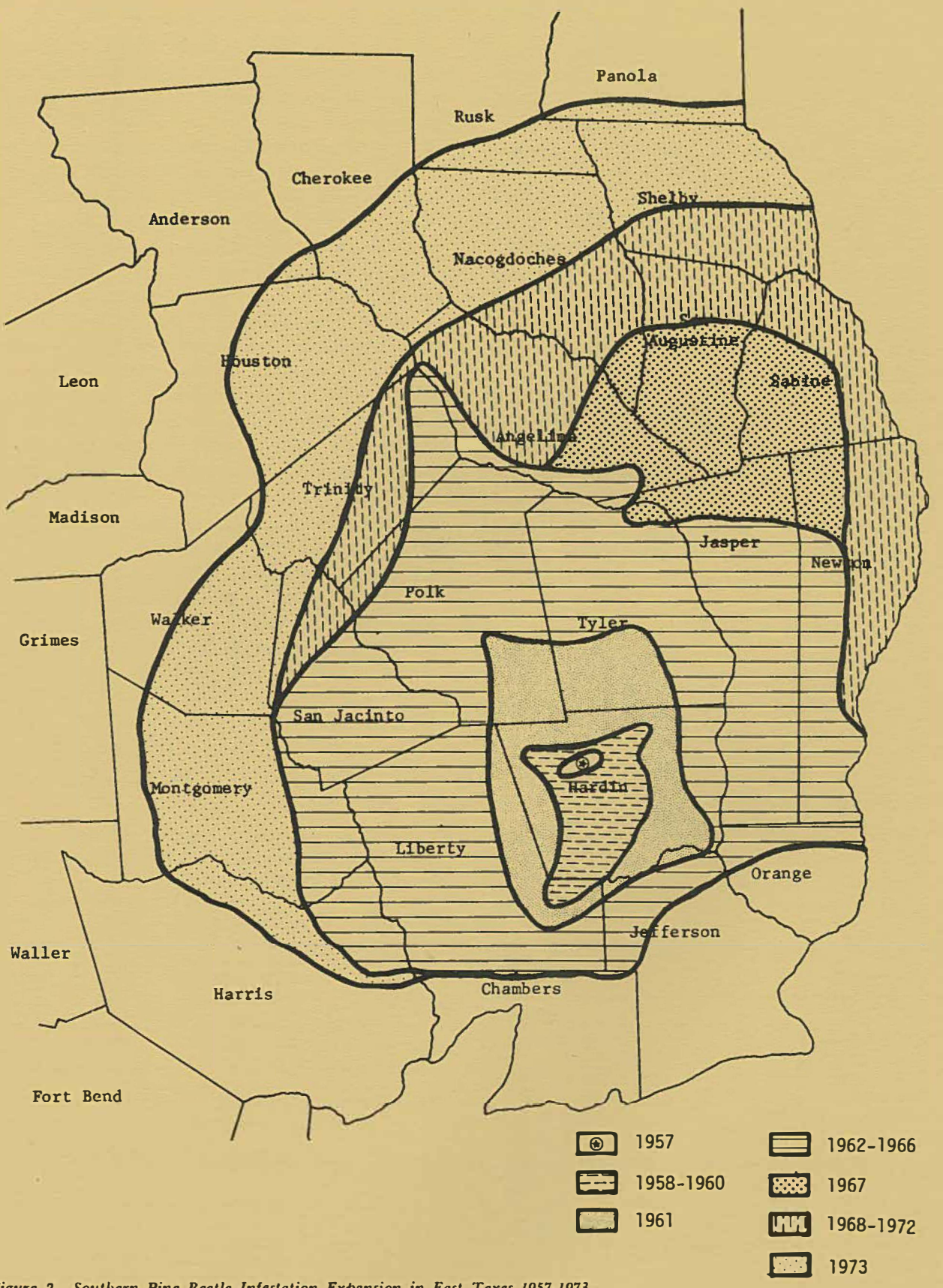


Figure 2. Southern Pine Beetle Infestation Expansion in East Texas 1957-1973.

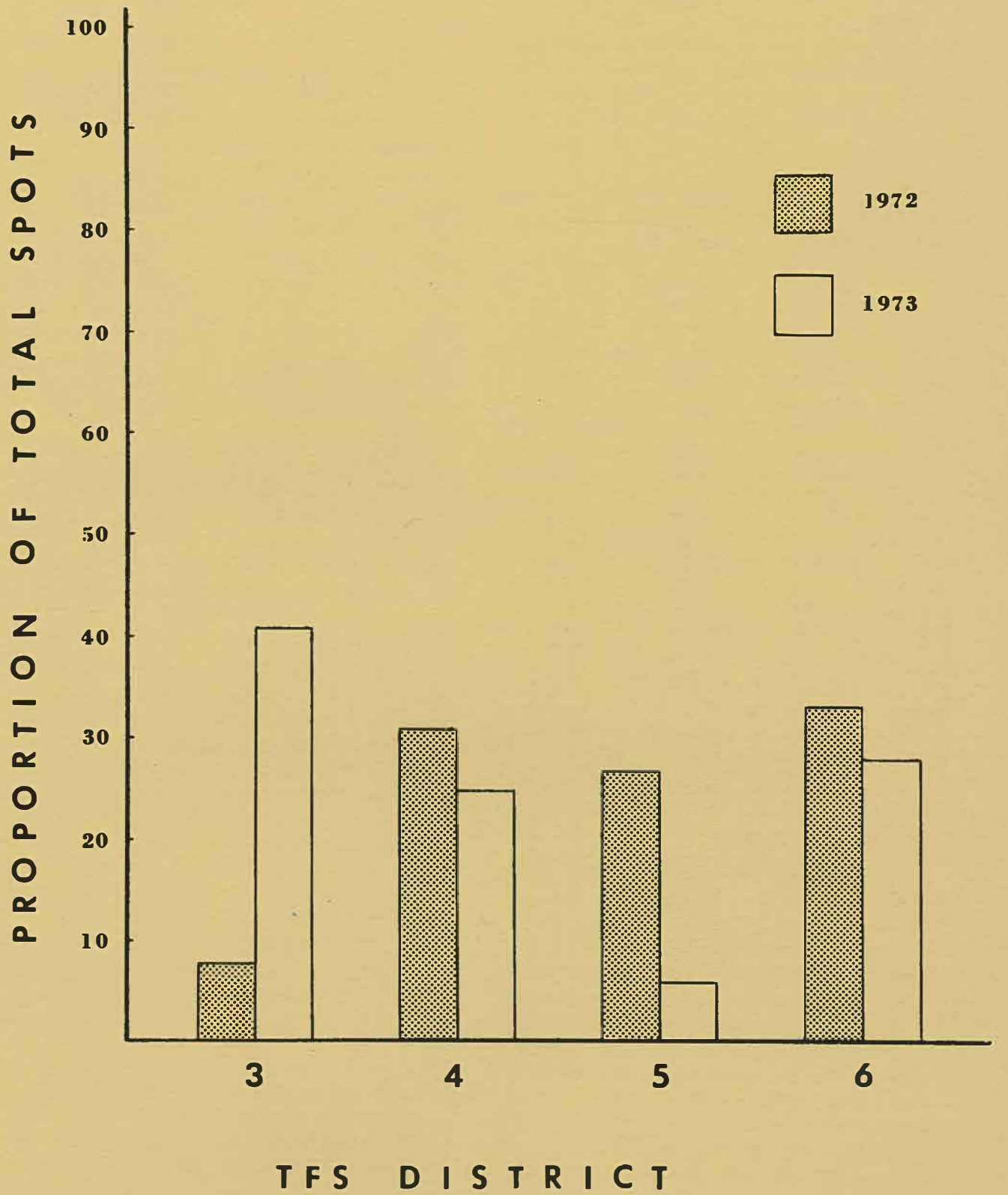


Figure 3. Distribution of Southern Pine Beetle Infestations Within the TFS Administrative Districts for 1972 and 1973.

Estimates of the total volume of pine timber killed by the southern pine beetle in East Texas from 1958 through 1973 are given in Table 4. As reflected by these figures, beetle activity during 1973 appeared to increase in sawtimber stands and decrease in pulpwood stands with respect to 1972. The estimated total volume of timber killed by the beetle increased in 1973 by 28 percent over the previous year.

TABLE 4. Estimated Volume of Pine Timber Killed by the Southern Pine Beetle in Southeast Texas Since 1958.

Year	Sawlogs (M bd. ft.)	Pulpwood (cords)	Total (M cu. ft.)
1958	500	0	84
1959	2,500	2,500	598
1960	8,000	8,000	1,912
1961	17,887	24,000	4,715
1962	93,043	111,110	23,538
1963	4,084	1,920	820
1964	2,501	1,420	520
1965	3,797	7,743	1,192
1966	6,256	6,930	1,544
1967	7,194	8,566	1,818
1968	17,644	22,037	4,533
1969	7,341	7,478	1,760
1970	4,318	14,730	1,782
1971	3,872	66,933	5,466
1972	24,710	50,393	7,755
1973*	38,595	45,983	9,900
Total	242,242	379,743	67,937

*Estimates for 1973 derived from sample of 1,980 salvaged and non-salvaged spots representing all spots on federal lands and ca. 37% of all spots on private lands.

OTHER BARK BEETLES

The black turpentine beetle, *Dendroctonus terebrans* and *Ips* bark beetles were reported active in portions of Fayette, Bowie, Cass, Morris, Titus, Camp, Upshur, Marion, Harrison, Gregg, Panola, Rusk and Cherokee counties as well as throughout the area infested by the southern pine beetle during 1972 and 1973. Compared to southern pine beetle, these beetles have caused only light damage, with most of the losses occurring in TFS Districts 1 and 2 (near Linden and Henderson). Attacks were attributed to various factors: construction or logging damage, fire, weather, lightning, and internal tree stress. In residential areas, where individual pines have high value, an application of benzene hexachloride has been used for remedial or preventive treatment against BTB attack. Salvage logging remains the recommended control procedure to reduce losses from both Ips and BTB in commercial forests.

DEFOLIATORS

Texas leaf-cutting ants or town ants, *Atta texana,* were reported as pests of pine seedlings in Shelby, San Augustine, Cherokee, Tyler, Jasper, Hardin and Nacogdoches counties. Mirex bait has been the primary means of control.

The fall webworm, *Hyphantria* spp., was particularly abundant in 1973, due presumably to the mild, wet weather. Webworm defoliation was common throughout East Texas, but damage was reported only from portions of Bowie, Cass, Morris, Titus, Camp, Upshur, Marion, Harrison and Gregg counties. In many areas two generations of this insect were observed. Trees most commonly attacked were pecan, hickory, persimmon, sweetgum, cherry and sycamore.

Among the other defoliating insects so common during 1973 was the walnut caterpillar, *Datana integerrina.* Pecan trees were repeatedly defoliated by this pest, particularly in portions of Fayette, Caldwell and Lee counties. In these and other pecan-growing areas of the state, chemical controls were necessary to safeguard the annual pecan crop.

TIPMOTHS

The pine tip moth, *Rhyacionia frustrana,* was reported active in portions of Bowie, Cass, Morris, Titus, Camp, Upshur, Marion, Harrison, Gregg and Bastrop counties in 1973. Within TFS District 1, Linden, numerous shortleaf pines 40 to 50 feet tall and smaller loblolly pine reproduction were heavily infested. This represents one of the most severe and widespread tipmoth infestations recorded in recent years in Northeast Texas.

FOREST DISEASES

Although a number of forest diseases continually produce degrade, decay and mortality in East Texas forests, they have generated little attention in recent years. Among the more common disease pests are annosus root rot, fusiform rust, needle cast, oak decline and lucidis root rot. Of these, annosus root rot, caused by *Fomes annosus,* is still considered the disease most harmful to the East Texas commercial forest. This disease, however, does not create the concern among land managers that it once did, even though certain pine stands continue to experience extensive losses. In particular, stands established on old field sites merit constant vigilance to detect disease infections.

RECENT ACTIVITIES AND DEVELOPMENTS

TFS PEST CONTROL SECTION

Historical Background

The current southern pine beetle outbreak in Texas was first detected in Hardin County in 1957. By 1962, southern pine beetle populations had developed to devastating proportions, infesting in 1962 an estimated 23,500,000 cubic feet of pine timber and pulpwood (Table 4). The alarming beetle situation led to the establishment of the Forest Pest Control Section to conduct aerial detection surveys and to coordinate efforts directed at controlling the bark beetle. In the following year, the Texas Forest Pest Law was enacted. This act gave the Texas Forest Service legal administrative responsibility in all matters concerning forest pests affecting Texas forest resources on state and private lands.

Pest Control headquarters were transferred from Woodville to the Cudlipp Forestry Center in Lufkin in 1964, and the staff was provided with new office and laboratory facilities in 1967.

The position of principal entomologist and Head of the Pest Control Section—was first held by Leroy Williamson (1962-1967) and later by Max Ollieu (1967-1969), Garland Mason (1969-1970), and Dr. Robert N. Coulson (1970-1972).

Present Activities

Although field-oriented activities relating to SPB detection and control are now handled largely by TFS district personnel, the Pest Control Section is responsible for providing necessary supervision, guidance, training and evaluation. Headquarters for the SPB Operations Informational System have been transferred from College Station to Lufkin so that the Pest Control Section can more closely monitor southern pine beetle operations.

Pest Control activities, however, are no longer focused entirely on the southern pine beetle. In 1972, a research project concerning seed orchard pests was begun and the Section staff often assists landowners and the district with a myriad of other pest problems.

In October 1973, a forest entomology seminar series was initiated to bring together professional forest entomologists from a variety of organizations in Texas, Louisiana and Arkansas. The seminar is held quarterly to provide interested workers with an opportunity to discuss forest pest problems and related research activities of joint interest.

Pest Control Staff

The Pest Control staff consists of the following persons:

Dr. Ronald F. Billings—Principal Entomologist

Ron, a native of Washington, joined the Section as principal entomologist on September 1, 1973. His special interest is in bark beetle ecology and host selection behavior. He has a B.S. in forest management from the University of Washington, a Master's degree in forest entomology from Oregon State University, and the Ph.D. in forest entomology from the University of Washington. As a Peace Corps volunteer from 1966 to 1969, he worked in programs of forestry and forest entomology in the Dominican Republic and in Chile. His present activities include a critical evaluation of the operational effectiveness of various SPB control tactics.

Garland N. Mason—Entomologist

Garland, born in Amherst, Texas, received his Bachelor of Forestry degree in 1966 and his Master of Forestry degree the following year from Stephen F. Austin State University. He first joined the Pest Control Section in September 1967 but took leave from August 1970 until January 1972 to return to graduate school at Texas A&M University. He expects to soon complete the Ph.D. degree in forest pathology. Meanwhile, he is conducting research on insect and disease pests associated with pine seed orchards while providing oft-requested expertise to landowners in forest disease problems.

Herbert A. Pase III—Entomologist

Joe, a native of Victoria, Texas, transferred from the Arkansas Forestry Commission to the Pest Control Section in May 1973 to replace Mark Houseweart, who returned to graduate school at the University of Minnesota. Joe has a Bachelor's degree in forestry and a Master's degree in forest entomology, both from Stephen F. Austin State University. From 1968 to 1970, he served as a medical entomologist with the U.S. Army in Thailand. His special interest is in ecology and taxonomy of sawyer beetles, the family *Cerambycidae*. At present, he is responsible for supervising and monitoring the recently established SPB Operations Informational System.

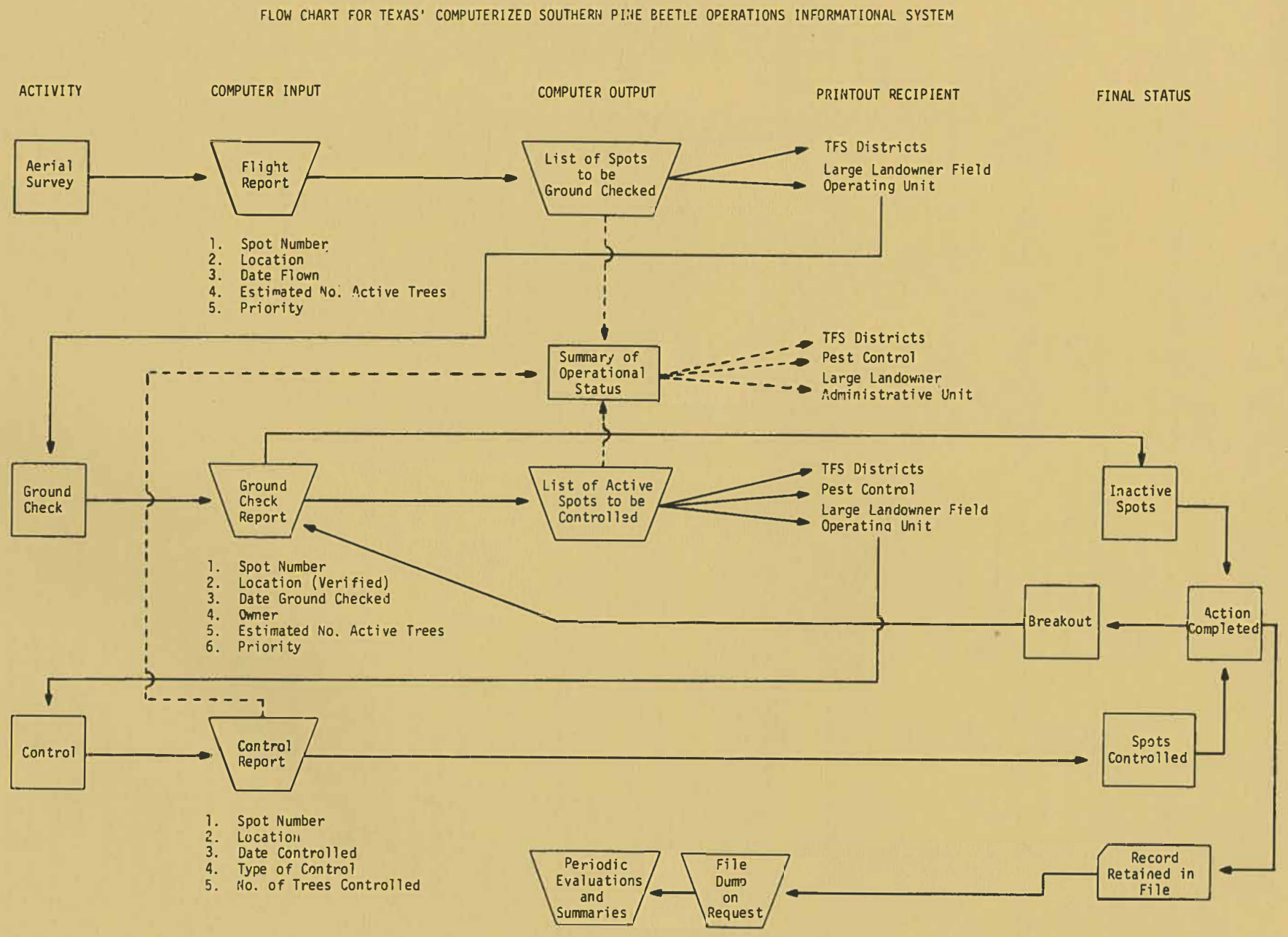


Figure 4. Flow Chart for Texas' Computerized Southern Pine Beetle Operations Informational System

Assisting Ron, Garland and Joe in the Pest Control Section are F. Alan Smith, specialist in research; Pauline Fagala, clerk II; and Judy Clark, seasonal laboratory technician.

SPB OPERATIONS INFORMATIONAL SYSTEM

The Texas Forest Service has legal responsibility for detection and control of southern pine beetle outbreaks on state and private forest lands throughout East Texas. Consequently, large and small timber owners alike rely upon the TFS to inform them of pest activity on their lands.

With the cooperation of the larger timber companies and the National Forests in Texas, the Texas Forest Service initiated the SPB Operations Informational System in March 1973 to facilitate statewide survey and control operations. A computer program was developed to handle all pertinent spot information. As shown in the simplified flow chart (Figure 4), the system involves up to three different input reports on any single spot: (1) a flight report following the aerial detection survey, (2) a ground check report, which provides more accurate information after a spot has been examined on the ground, and (3) a control report indicating how and when a spot was controlled. All records concerning beetle spots are placed on computer punch cards as soon as they are received from field offices. Periodic printouts providing up-to-date lists of spot information are then sent to district offices (from which the field data originated), and to the larger landowners within whose forests the current infestations occur.

In addition, operational summaries are sent to the administrative units of cooperating industries and to the U.S. Forest Service so that supervisors are kept up-to-date on the pest activity and control status on their lands. Printouts are received at weekly or bi-weekly intervals during the active beetle season (April-September) and at monthly intervals when beetle activity is low. Also, a statewide summary is distributed periodically to cooperators by the TFS Pest Control Section.

Since a spot once controlled or reported inactive no longer appears on the weekly printouts, the system provides a visual incentive for field personnel to reduce the number of spots requiring ground check or control action.

Although designed specifically for operational purposes, the system also has proven beneficial to research workers. For the first time, SPB survey data is immediately available in a form that can be analyzed by computer to test for population trends and other ecological relationships. TFS Pest Control personnel are now in the process of closely scrutinizing the 1973 SPB data deck by means of various computer analyses.

CURRENT RESEARCH ON SOUTHERN PINE BEETLE IN TEXAS

If a permanent solution to the southern pine beetle is to be achieved, it must come from intensive research efforts. Fortunately, a number of organizations in Texas and elsewhere are pursuing active research programs designed to explore various aspects of SPB ecology and control. The research organizations in Texas and their areas of interest are listed below.

Universities: A cooperative research project involving forest entomologists at Texas A&M University and Stephen F. Austin State University, with support from the U.S. Forest Service Southern Forest Experiment Station in Alexandria, Louisiana, was begun in 1972. The goal is to further define processes of SPB host selection and attack behavior in loblolly pine stands. Specific areas of investigation include the response of field and laboratory beetle populations to insect pheromones and host volatiles, isolation and identification of chemical messengers, and pattern of beetle attack in young pine stands. The project is being directed by Dr. Thomas L. Payne of Texas A&M University and Dr. Jack Coster of Stephen F. Austin State University.

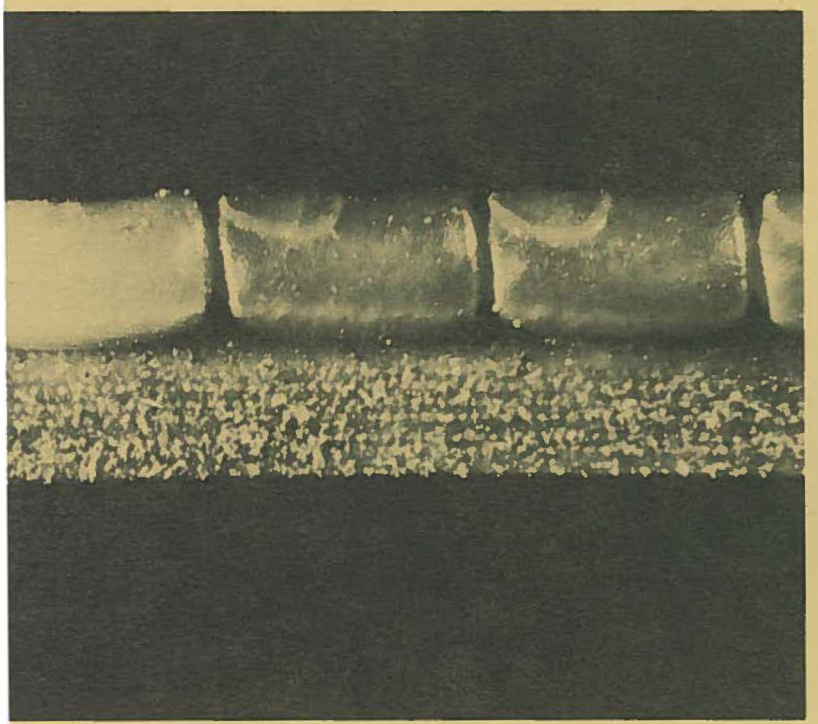
Southern Forest Research Institute: Under the direction of Dr. Patrick Hughes of the Boyce Thompson Institute, the SFRI research project continues to investigate bark beetles affecting southern pines. Recent research efforts have been aimed at clarifying biochemical variation in pheromone systems of *Ips* and disjunct southern pine beetle populations.

International Biological Program **Integrated Pest Management Project:** The southern project of the IBP, under the guidance of Dr. Robert N. Coulson at Texas A&M University, is in the process of developing sampling techniques for within-tree populations of the southern pine beetle. The ultimate goal is to develop a life table for the beetle and to evaluate factors influencing pest population dynamics.

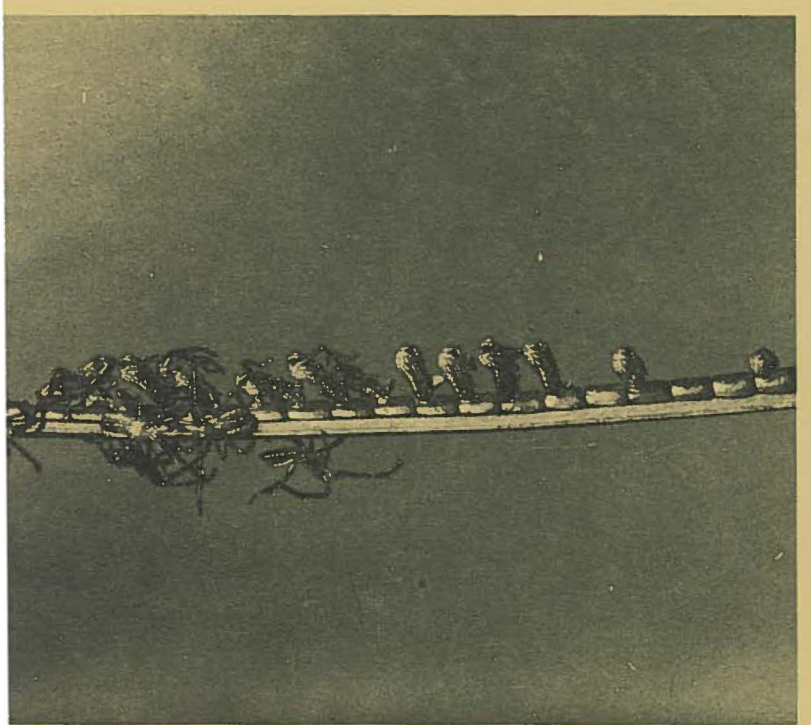
Texas Forest Service: Using statewide survey and control data provided by the computerized SPB Operations Informational System, the Pest Control Section has begun a critical evaluation of the operational effectiveness of various SPB control tactics—salvage, cut and leave, cut and top, no control, etc. Field data on the effectiveness of cut

Figure 5. Developmental Stages for the Seedbug, Leptoglossus corculus (Say) (Hemiptera: Corcidae), an Important Pest in Pine Seed Orchards.

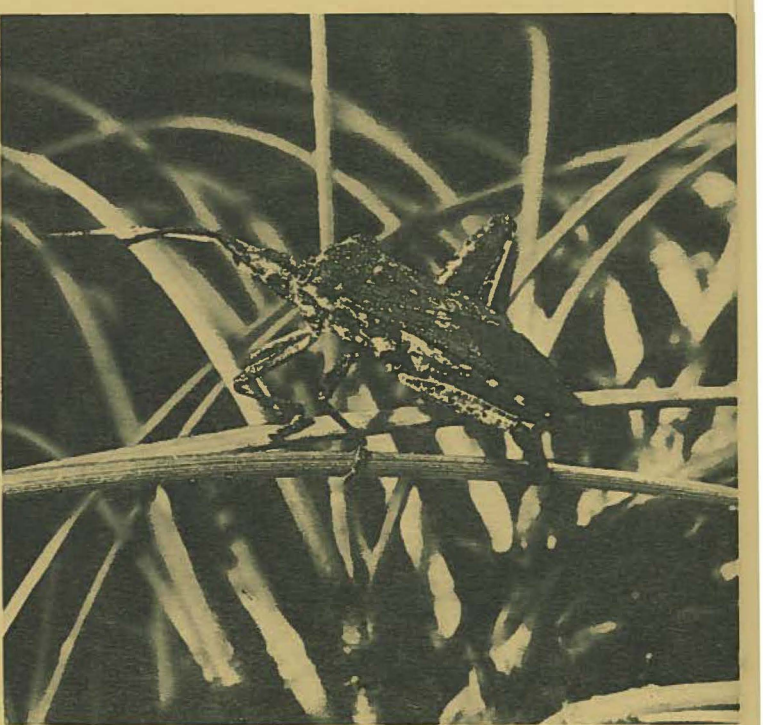
Eggs laid on loblolly pine needle (X25).



First-instart nymphs hatching from eggs (X25).



Nymphs hatching in sequence from eggs attached to pine needle.



Adult seedbug resting on first-year female cone of loblolly pine.

and leave tactics also are being obtained from individual spots with the cooperation of TFS district personnel. The goal is to ascertain the overall impact of various control techniques on reducing beetle-caused timber losses.

SEED ORCHARD PEST RESEARCH

During the past decade, the establishment of pine plantations has continued at a rate of almost ¾ million acres per year in the 13 Southeastern states. In 1971, Texas pine plantation inventory stood at almost 280,000 acres; this figure is projected to exceed 550,000 acres within the next six years.

To furnish a continuous supply of quality trees and a dependable source of seed for the future, seed orchards have been established from selected superior trees. The utilization of genetically improved planting stock from these seed is expected to increase production, decrease rotation time and provide a higher quality product. Although the production of high quality seed for forestry is in its infancy, numerous biological agents detrimental to seed production have already been recognized.

In January 1972, the Pest Control Section initiated a research project on seed orchard pests. Major objectives were twofold: (1) to identify and measure impact of the various seed- and cone-destroying agents in order that control priorities could be established, and (2) to evaluate various chemicals for direct suppression of important pests. Progress to date is summarized herein.

Unlike familiar crop plants, pines require two growing seasons for the production and maturation of seeds. This process creates an extended exposure period during which weather extremes and various seed- and cone-destroying agents may take a tremendous toll. Larvae of the pine tip moth (*Rhyacionia* spp.) may kill flowers and conelets directly by mining the structure or indirectly by boring in the central portion of the supporting stem, killing the entire twig. The coneworms (*Dioryctria* spp.) have long been considered the most important orchard pests, largely because they may attack conelets, cones, shoots, bases of overwintering cones, and fusiform rust cankers, as well as the basal stem of the tree. Other boring lepidoptera, the seedworms (*Laspeyresia* spp.) and members of the genus *Eucosma*, cause sporadic but often heavy losses. Cone midges (Diptera: Cecidomyiidae) have been reported as primary pests of southern pine cones. Midge larvae are very small and feed within the cones on the inner surfaces of the scales and succulent seed, causing distortion of the cone and seed morality. The seedbugs *Leptoglossus corculus* (Figure 5) and *Tetyra bipunctata* have been recognized as orchard pests only within the past decade. Their biology and impact are under continued investigation. Feeding by *L. corculus* causes flower and conelet abortion as well as empty seed in mature cones.

It is speculated that a combination of all losses from flower to nursery seedling results in a seed production efficiency of less than 1 percent. With recent values of improved seed at $100 to $1000 per pound, this represents a tremendous economic loss.

Losses in Texas seed orchards ranged from 5 percent of flowers and conelets in 1972 to 68 percent in 1973. An absence of second-year cones due to an early spring freeze prevented evaluation of cone loss in 1972. A 7 percent loss was observed in 1973—far below recorded averages for the area.

Five chemicals were tested in the 1973 insecticide evaluations—hydraulic sprayer applications of Guthion and Gardona; and soil applications of the granular systemics Furadan, Di-Syston and Thimet (Figure 6). As a result of the above cone situation, however, chemical evaluation results have been inconclusive; there simply were not a significant number of cones or insect losses to effectively test chemical controls. Testing of two of the most promising chemicals, Guthion and Furadan, will be continued in 1974 as a part of a southwide study in cooperation with the newly formed Southern Seed Orchard Pest Committee.

POINTS TO PONDER

This section of the Annual Report is reserved for interpretive articles dealing with the broader environmental implications of entomological activities. The purpose of the following article is to stimulate thought and, perhaps, to foster among readers a more profound appreciation for the complexity of natural systems.

The Possibility of Genetic Changes in Bark Beetle Populations

A geneticist at Texas A&M University recently developed a computer model to simulate evolutionary changes. Although basically very simple, the model vividly illustrates the tremendous power of natural and artificial selection in producing changes in a population such as a herd of cattle, a stand of trees or a horde of beetles. Of particular interest to pest management is the number of generations over which change is established in response to increases in artificial selection pressures.

Figure 6. Aerial Lift Truck Facilitates Research on Impact of Insect and Disease Pests in Texas Pine Seed Orchards (Magnolia Springs).

Natural mutation processes by themselves might require a period of 1,000 to 10,000 generations to cause measurable changes in a given population. The computer model demonstrates that such changes could take place in 25 generations or less with the addition of artificial selection pressures such as loss of preferred habitat or most man-made control measures. Because of marked differences in reproductive rates, it might take 500 to 1000 years for a noticeable change to occur in a stand of trees, but only three or four years for a population of southern pine bark beetles to accomplish the same.

Although no proof is available, it is highly probable that most procedures used to control bark beetles will in turn cause the bark beetle populations to change. Sustained epidemics or forest management activities also may cause an artificial selection pressure through change in preferred habitat. That such changes do take place is borne out by the repeated experiences of agricultural entomologists. Constant application of the same insecticide commonly produces genetic resistance in insects after only 10 or 20 generations. Also, the documented ability of certain forest insect species to abruptly change their preferred host species is thought to be an expression of selective environmental pressure on the population. Conceivably, selective pressure might exhibit itself in the case of southern pine beetle by increasing the beetle's appetite for pines growing at wider spacings on upland sites as opposed to densely stocked stands on poorly drained sites.

Although this simplistic theoretical model provides only a gross interpretation of genetic phenomena, the implications are clear and should not be ignored in developing pest management strategies. Among the generalities suggested by this model are that (1) it is unlikely that any single control method will provide a permanent solution to our bark beetle problems (thus, a management strategy that encompasses many methods is to be preferred), (2) the longer a specified control method is applied, the less effective it will tend to be, and (3) any effective beetle management strategy must include a feed-back system to monitor possible population changes. In turn, the strategy must be flexible enough to react to the indicated changes.

Perhaps even the development of a genetically resistant tree may provide only a temporary solution. Indeed, the model suggests that bark beetles, with their high population level and extremely short life cycle, would have the innate capacity to soon overcome induced resistance mechanisms.

APPENDIX I

TFS DISTRICT REORGANIZATION

On September 1, 1973, the Texas Forest Service underwent district reorganization in order to better serve the public. Not only did some administrative districts change boundaries but a number of sub-districts also were established. Present District and Sub-District boundaries are shown in Figure 7. With more Texas Forest Service offices now in operation, it should be more convenient for landowners to consult foresters concerning protection problems and other forestry needs. The address, phone number and name of the person in charge at each office are listed below. Some sub-district offices have yet to be established.

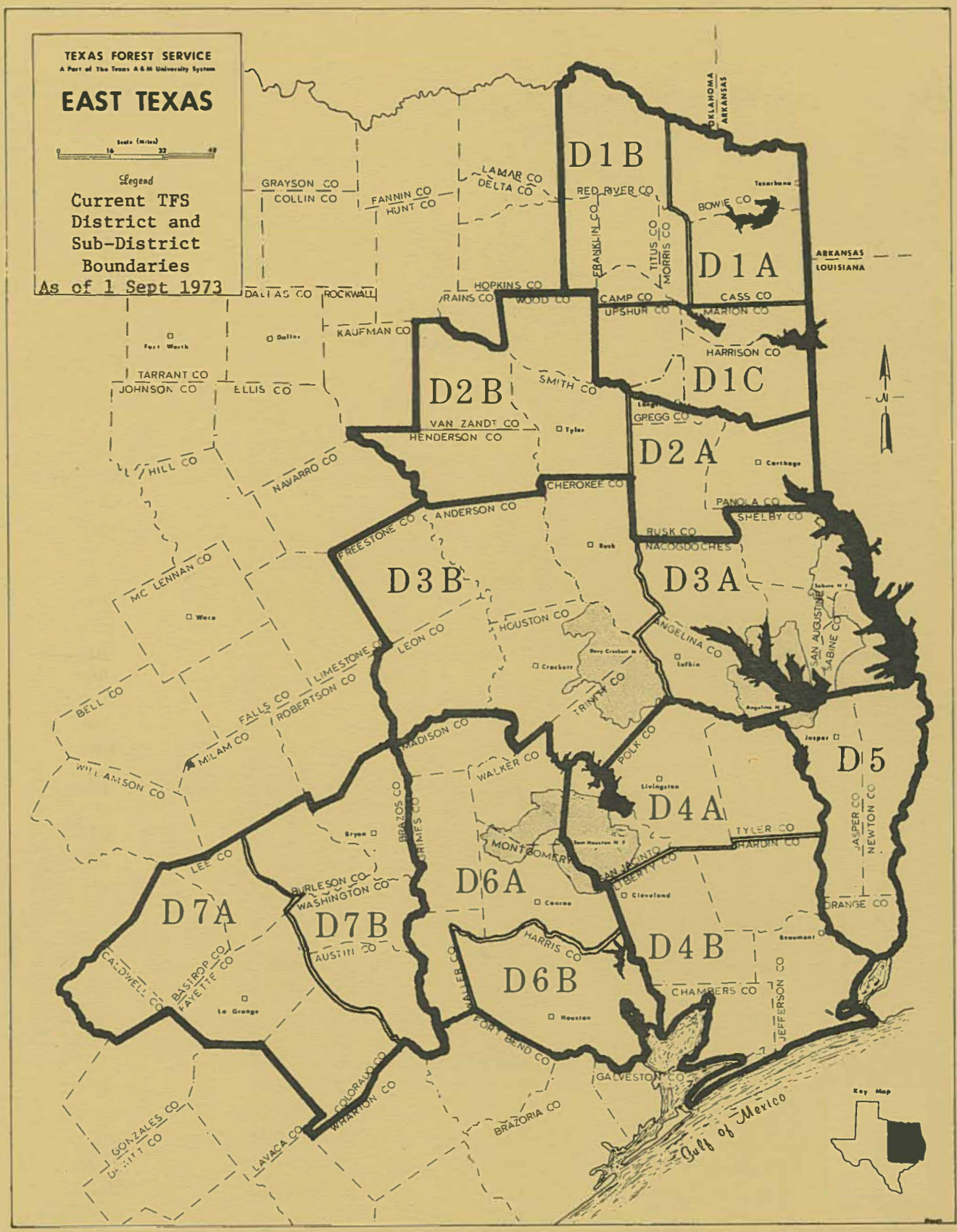


Figure 7. Current TFS District and Sub-District Boundaries.

APPENDIX II

1973 COUNTY SUMMARY OF SPB SPOT INFESTATIONS.

County totals	Total number spots	Total number spots controlled	Total number spots inactive (as of 31 Dec.)
Montgomery	497	193	244
Trinity	322	62	117
Nacogdoches	320	71	224
Angelina	311	96	162
San Jacinto	289	91	166
Walker	285	101	121
Polk	284	98	141
Tyler	239	101	124
Liberty	210	66	95
Hardin	204	112	73
Jasper	192	70	75
Houston	161	18	54
Cherokee	150	39	84
Shelby	128	46	72
San Augustine	108	39	42
Rusk	46	12	31
Newton	23	5	8
Orange	22	6	11
Sabine	17	5	9
Chambers	17	3	13
Panola	8	1	7
Harris	7	3	4
Anderson	5	2	2
Jefferson	4	0	4
Grimes	2	0	2
Waller	2	2	2

APPENDIX III

MARS* SUMMARY OF 1972 - 1973 SOUTHERN PINE BEETLE DETECTION AND GROUND CHECK ACTIVITIES BY TFS DISTRICT PERSONNEL.

Detection Method	Detection Periods		
	1 July - 31 Dec. 1972	1 Jan. - 30 June 1973	1 July - 31 Dec. 1973
Aerial survey			
Acres covered	33,103,480	17,662,454	33,328,072
Man-hours	1,077	357	795
Ground check			
Man-hours	1,947	2,545	5,904**

*Multiple Accomplishment Reporting System (US Forest Service)

**The great amount of time spent by TFS crews in ground check activities during the latter part of 1973 resulted from unusually high rainfall, which freed crews from fire duty.

District or Sub-District	District or Sub-District Forester	Location	Address	Telephone
1	Steve W. Adams	Linden	P.O. Box 469	214-756-5571
1A	Kenneth E. Conaway	Linden	P.O. Box 469	214-756-5571
1B	Gerald A. Teachenor	Mt. Pleasant	P.O. Box 1326	214-572-5029
1C		Gilmer	P.O. Box 149	214-843-3921
2	Henry W. Rehling	Henderson	P.O. Drawer 792	214-657-4898 657-4033
2A	John W. Hale	Carthage	P.O. Box 195	214-693-6865
2B	Joe Fox	Tyler	SE Loop 323	214-597-2603
3	Robert H. Bloom	Lufkin	P.O. Box 310	713-632-7746 632-7745
3A	Ed Applequist	Center	P.O. Box 968	713-598-2192
3B	John C. Jones	Crockett	501 Lamar	713-544-7798
4	Arthur E. Green	Woodville	P.O. Box 336	713-283-3785
4A	Donald L. Staples	Livingston	Route 1, Box 39	713-327-4832
4B	Charles P. Richards	Kountze	P.O. Box 146	713-246-2484
5	James B. Hull	Kirbyville	P.O. Drawer 281	713-423-2890 423-4411
6	James T. Blott	Conroe	Route 7, Box 151	713-273-2251 273-2261
7	John W. Stine	La Grange	P.O. Drawer G	713-968-5556